Claims

1. A method for fabricating a silicon-on-insulator (SOI) material by using an implanting oxygen ions into a silicon containing substrate having a major surface, comprising the steps of:

(1) implanting oxygen ions at a first dose and a first energy through said major surface into said silicon containing substrate controlled at a first temperature;

(2) implanting second kind of ions at a second dose and a second energy through said major surface into said silicon containing substrate at a second temperature below 100°C, to form an amorphous region beneath the major surface and to keep the original structure in the major surface of said silicon containing substrate;

(3) annealing aforesaid silicon containing substrate at a third temperature to form a buried oxide layer by combining oxygen implanted in step (1) with silicon in the substrate, and a top silicon layer including the said major surface isolated by the buried oxide layer.

2. The method of claim I wherein the said third temperature is chosen to be in the region from 1250°C to below silicon melting point, eliminating the threading dislocations in the top silicon layer and reducing the surface dislocations to the lowest density to form SOI material.

3. The method of claim I wherein the said third temperature is selected in the range from 900°C to 1250°C, eliminating the threading dislocations in the top silicon layer, and silicon islands and pinholes in buried oxide layer to form SOI material.

4. The method of claim I wherein the said first dose is determined by the desired thickness of said buried oxide layer, which will be formed after said annealing process in the step (3).

5. The method of claim 4 wherein the said first dose is in the range from 1×10^{16} cm^{-2} to 5×10^{18} cm^{-2}.

6. The method of claim I wherein the said first energy is chosen to form enough depth of said buried oxide layer after said annealing process in step (3), so as to form a desired thickness of the top silicon layer.

7. The method of claim 6 wherein the said first energy is in the range from 50keV to 400keV.

8. The method of claim I wherein the said first temperature is chosen to keep the original structure in said major surface of said silicon containing substrate in the first ion implanting process.

9. The method of claim 8 wherein the said first temperature is in the range from 450°C to 700°C.

10. The method of claim 1 wherein the said second energy is chosen in the range from 30keV to 5MeV to form an amorphous region beneath the said major surface and to keep the original structure in the major surface of said silicon containing substrate during the implantation in step (2).

11. The method of claim 1 wherein the said second dose is chosen in the range from 1×10^{13} cm^{-2} to 5×10^{16} cm^{-2} to form an amorphous region beneath the major surface containing both a majority of top silicon layer and all the buried oxide layer, which is formed in step (3).

12. The method of claim 1 wherein the said second kind of ion is silicon ion.

13. The method of claim 1 wherein the said second kind of ion is germanium ion.

14. The method of claim 1 wherein the said second kind of ion is inert gas ion.

15. The method of claim 1 wherein the said second kind of ion is oxygen ion.

16. A method for eliminating silicon islands and pinholes in the buried oxide layer of SOI material formed by using SIMOX method, comprising the steps of:

(1) implanting silicon ion, germanium ion, inert gas ion or oxygen ion at a dose and an energy into SOI material containing top silicon layer and buried oxide layer at

a temperature below 100°C, to form an amorphous region including said buried oxide layer and to keep the original structure in vicinity of said major surface;

(2) annealing aforesaid SOI material at a temperature in the range from 900°C to 1250°C to restore structure of every layer and to eliminate silicon islands and pinholes in said buried oxide layer.

17. The method of claim 16 wherein the said energy is in the range from 30keV to 5MeV.

18. The method of claim 16 wherein the said dose is in the range from 1×10^{13} cm^{-2} to 5×10^{16} cm^{-2}.

19. A method for forming high quality of SOI material on a silicon containing substrate having a major surface by using SIMNI method, comprising the steps of:

(1) implanting nitrogen at a first dose and a first energy though said major surface into said silicon containing substrate controlled at a first temperature;

(2) implanting second kind of ion at a second dose and a second energy though said major surface into said silicon containing substrate at a second temperature below 100°C, to form an amorphous region beneath said major surface and to keep the original structure in said major surface of the silicon containing substrate; and

(3) annealing aforesaid silicon containing substrate at a third temperature in the range from 900°C to below the melting point of silicon, to combine the first implanted nitrogen and silicon and to form a buried nitride layer and a top silicon layer, which includes said major surface, isolated by the buried nitride layer.

20. The method of claim I9 wherein the said first dose is chosen to form a desired thickness of said buried nitride layer after said annealing process in step (3).

21. The method of claim 20 wherein the said first dose is in the range from 1×10^{16} cm^{-2} to 5×10^{18} cm^{-2}.

22. The method of claim 19 wherein the said first energy is chosen to form enough depth of said buried nitride layer after said annealing process in step (3), so as to form a desired thickness of the top silicon layer.

23. The method of claim 22 wherein the said first energy is in the range from 50keV to 400keV.

24. The method of claim 19 wherein the said first temperature is chosen to keep the original structure in vicinity of said major surface on silicon containing substrate in said first implantation process of step (1).

25. The method of claim 24 wherein the said first temperature is in the range from 450°C to 700°C.

26. The method of claim 19 wherein the said second energy is chosen in the range from 30keV to 5MeV to form an amorphous region beneath the said major surface and to keep the original structure in the major surface of said silicon containing substrate during the implantation in step(2).

27. The method of claim 19 wherein the said second dose is chosen in the range from 1×10^{13} cm^{-2} to 5×10^{16} cm^{-2} to form an amorphous region beneath the major surface containing both a majority of top silicon layer and all the buried oxide layer, which is formed in step(3).

28. The method of claim 19 wherein the said second kind of ion is silicon ion.

29. The method of claim 19 wherein the said second kind of ion is germanium ion.

30. The method of claim 19 wherein the said second kind of ion is inert gases ion.

31. The method of claim 19 wherein the said second kind of ion is oxygen ion.

32. The method of claim 19 wherein further comprising an oxygen ion implantation process before said step (2) at the same energy as the first one, at a dose for easily forming amorphous structure from buried oxynitride layer, which will be formed in the annealing process of step (3).

33. The method of claim 32 wherein selecting the second ion implanting dose and energy in step (2) for forming an amorphous region beneath said major surface in a majority of top silicon layer and all the buried oxynitride layer, which will be formed in annealing process of step (3); for keeping the original structure in said major surface of silicon containing substrate; and for enhancing the diffusion of various atoms in amorphous region, especially first implanted nitrogen, in the annealing process, to form a good insulating buried layer and a sharp interface between the top layer and the buried layer.